MIDDLE SCHOOL SCIENCE AND MATHEMATICS TEACHERS' CLASSROOM PRACTICES OF IMPLEMENTING REASONING SKILLS

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Abstract. This study aimed at assessing the current practices of middle school science and mathematics teachers in implementing scientific reasoning skills in their classrooms to enhance students reasoning and whether there is difference with respect to gender, educational level, and subjects they teach. The study group consisted of 154 teachers (43 females and 111 males) in three regions of Ethiopia. Mixed research method was used and data were collected with Likert scale questionnaire consisting of 23 questions and four major interview questions. The findings showed that the teachers moderately practice implementing reasoning skills while teaching science and mathematics to enhance students reasoning skills. They frequently used few of the reasoning skills but moderately for most of them. The qualitative data also supported this result and indicated that teachers have many challenges in implementing reasoning skills. The findings from independent samples t-test and ANOVA illustrated that there was no significant difference between teachers' practices in implementing rea-

soning skills to enhance students' reasoning skills with respect to gender, education level and subjects they teach. Professional development intervention was recommended to build the capacity of teachers in implementing reasoning skills.

Keywords: scientific reasoning, scientific reasoning skills, middle school teachers, science and mathematics

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Introduction

The current fast changes in science and technology have highly affected the world education system. Learning theories have been changing to adapt this situation. The shift in learning theory from behaviourism to constructivism, to multiple intelligence had an enormous impact on the teaching and learning of science and mathematics (Hatfield et al., 2003). According to Von Glasersfeld (1989) students acquire knowledge by constructing and restructuring it over time which is similar to the experiential learning theory by Dewey (1997). An individual learns by doing or experiencing, and teachers should facilitate students' learning for attaining knowledge developmentally (Dewey, 1997). In order to make the learning of science and mathematics meaningful, teachers are responsible for choosing and posing tasks that engage students actively in building their understanding, critical thinking, reasoning and confidence (Kulm, 1994).

For many decades, science education reformers have promoted the idea that learners should be engaged in the excitement of science; they should be helped to discover the value of evidence-based reasoning and higher-order cognitive skills, and be taught to become innovative in their life (Nelson, 2008; Perkins & Wieman, 2008). But the means to achieve these goals, especially methods to promote creative thinking and scientific reasoning, are either not widely known or used, or are debated. In science and mathematics classrooms, fostering inquiry-based learning and developing reasoning skills are among the most important learning goals (Jonassen, 1997).

Reasoning skills are important components of teaching and learning of science and mathematics education. Reasoning can be defined as the mental processes involved in generating and evaluating logical arguments used to derive inferences (Anderson, 1990; She & Liao, 2010; Jaleel & Premachandran, 2017).

Scientific reasoning, according to Giere et al. (2006), is the cognitive skills necessary to understand and evaluate scientific information and solve problems from the science and mathematics literacy perspective. It is also the thinking and reasoning skills involved in inquiry, experimentation, evidence evaluation, inference and argumentation that support the formation and modification of concepts and theories about the natural and social world from research perspectives in science and mathematics (Zimmerman, 2005). Scientific reasoning was considered as a very important issue in scientific, critical, and creative thinking, argumentation, problem solving, and decision making (Jaleel & Premachandran, 2017).

Literatures indicated that reasoning can be domain specific or domain general in science learning. For instance, in the domain-specific reasoning, a typical scientific reasoning activity can be questions or problems that need students to use their conceptual knowledge of a particular scientific phenomenon (Zimmerman, 2000). Examples of domain specific questions or problems about the earth include "is there an edge to the earth? Can you fall off the edge?" (Vosniadou & Brewer, 1992). Moreover, domain specific questions about genetics include "how does it come about that people have different color of eyes/hair? How did the differences between horses and cows originate?" (Samarapungavan & Wiers, 1997). Similarly, in physics students can be asked domain specific questions like draw the path of a ball as it exits a curved tube (Kaiser et al.,1986) or predict the trajectory of a falling object (McCloskey, 1983).In the examples mentioned above students were not expected to evaluate evidence, make observations, or conduct experiments to confirm their solutions or answers.

In contrast to domain specific reasoning, students can be engaged in designing experiments (Schauble, 1996) in domain general reasoning. Moreover, in domain-general reasoning, students are involved in the discovery and modification of theories and include the general cognitive skills implicated in experimental design and evidence evaluation that transcend the particular content domain to which they are being applied (Zimmerman, 2000).

According to Jaleel & Premachandran (2017), scientific reasoning has different components. These are problem identification, interpretation of results, making logical conclusions, deductive reasoning and inductive reasoning. They stated that exact problem identification which is built from an analysis of a situation, needs proper scientific reasoning ability among the students. Similarly, interpretation of results obtained from data must have a clear scientific base and should be the result of proper scientific reasoning.

According to Lawson (1994) deductive reasoning or deduction is a basic form of valid reasoning in which student starts out with a general statement, or hypothesis, and examines the possibilities to reach a specific, logical conclusion. On the other hand, in inductive reasoning or induction, students make broad generalizations from specific observations. Deductive reasoning is an extremely important aspect of scientific thinking because it underlies a large component of how student conduct their experiments (Lipton, 1998). In science, there is a constant interplay between these two reasoning mechanisms.

Different mathematical problem solving strategies depend on scientific reasoning (Morris et al., 2012; Tajudin & Chinnappan, 2015). According to Kilpatrick et al. (2001), mathematical reasoning refers to the ability to formulate and represent a given mathematics problem, and to explain and justify the solution or argument. One or more reasoning skills are required in problem solving processes. In understanding a problem situation, the problem solver may need to distinguish between facts and opinions; in formulating a solution, the problem solver may need to identify relationships between variables; in selecting a strat-

egy, the problem solver may need to consider cause and effect; and, in communicating the results, the problem solver may need to organise information in a logical manner. The reasoning skills associated with these processes are embedded within problem solving. Examples of reasoning skills employed in problem solving include deductive, inductive, quantitative, correlational, analogical, combinatorial, and multidimensional reasoning. These reasoning skills are not mutually exclusive and often in practice problem solvers move from one to another in gathering evidence and testing potential solution paths before settling into the major use of one method over others in finding the solution to a given problem.

Scientific reasoning as part of cognitive abilities of critical thinking and reasoning skillshas an impact on student's academic achievement (Tajudin & Chinnappan, 2015). Students' academic achievement is also dependent on the skills they have about the inquiry process which includes designing experiments, analyzing and evaluating the results of investigation, and understanding which are in turn affected by students reasoning ability (Zimmerman, 2005). According to Kramarski et al., (2001), there is a direct relationship between reasoning skills and success in mathematics. Jaleel & Premachandran (2017) also noted that there is significant positive correlation between achievement in chemistry and scientific reasoning of secondary school students. It is point out that those students who exhibit better reasoning skills show good problem-solving skills (Kramarski et al.,2001) and reasoning ability is needed in problem-solving (Susilowati & Anam, 2017).

Reasoning thus helps students in generating new knowledge and organizing the existing knowledge to make it more usable for future mental work (Jaleel & Premachndra, 2017). Scientific reasoning helps students to think at a deeper level to analyze complex and abstract concepts of science and to organize the knowledge structure systematically into their cognitive structure or schema

(Jaleel & Premachandran, 2017). The reasoning is needed to understand complex theories and concepts, avoid scientific misunderstandings and necessary for complex decision-making and problem-solving (Susilowati & Anam, 2017).

Due to these, reasoning becomes central to scientific, critical, and creative thinking, and for argumentation and problem solving skills in science and mathematics. Students' performance on scientific and mathematical reasoning is important and it needs to be developed in science and mathematics teaching and learning process in all education levels (Chen & Klahr, 1999), it can be developed through training and can be used in academics (Piraksa et al., 2011). However, previous research found that teachers and the overall teaching and learning approach give more emphasis on material than deeper understanding where teachers focus on questions to improve the cognitive knowledge, while scientific reasoning skills had never been trained to the students (Susilowati & Anam, 2017). As a result of this, students' performance and understanding of concepts in science and mathematics has been observed decreasing from time to time. With an attempt to revert the situation these days teaching-learning is shifting from teacher centered traditional learning to effective student centered learning that engage learners in their learning (Siu, 1999) and this is believed to students to develop scientific reasoning skills.

To this end various student centered methods and strategies have been proposed in teaching and learning of science and mathematics that includes cooperative learning, visualization techniques, learning cycle, problem based learning, etc.

Therefore, developing and enhancing the ability of reasoning skills of students have been a priority area of science education aiming to increase students' academic achievement (NRC, 1996). And appropriate strategies must be chosen and implemented to enhance students reasoning abilities in learning science and mathematics. . In view of the important role of reasoning in science and mathematics learning, science teachers need to develop an understanding of

scientific reasoning procedures and know their roles. Their role begins from designing activities that encourage reasoning and they need to emphasize on various steps of reasoning.

Hence, this study studies the current practices of middle school science and mathematics teachers in developing reasoning skills since one of the purposes of teaching Science and Mathematics is developing students' knowledge and scientific reasoning ability in order to enhance their academic performance.

Statement of the problem

Good reasoning skills empower students in their educational, professional, and personal lives. Nationally and internationally, there is growing recognition that if education is to produce skilled thinker and innovators in a fast-changing global economy, then reasoning skills are more important than ever. The ability to reason in a range of learning contexts is essential for the development of knowledge, understanding and performance. Reasoning skills had been adopted in Ethiopia as one of the nation's educational goals to make students creative (TGE, 1994) owing to its importance. According to Niaz (1996) students who were successful in solving problems and those with high proportional reasoning ability tend to use algorithmic reasoning strategies more frequently than non-successful and low proportional reasoning students. Students' academic achievement depends on their reasoning skills (Kramarski et al., 2001; Zimmerman, 2005). Hence, teachers are expected to implement reasoning skills in teaching and learning process of science and mathematics education so as to enhance students reasoning skills. Teachers are responsible for building students reasoning skills in learning science and mathematics (Kulm, 1994). For enhancing reasoning skills, it is important to guide students, provide feedback and introduce strategic methods and models (Asieba & Egbugara, 1993). Learner centered approach is believed to create opportunities for students to develop scientific reasoning skills and scientific reasoning skills are expected to be taught in science classes to prepare students for meaningful learning

(Susilowati & Anam, 2017). As a result, the Ethiopian education system has given a great emphasis on implementing active learning methods in schools at all education level in the past few years. However, reasoning skills need to be fully incorporated and given wide recognition as one of the major concepts in the teaching learning process as academic achievement of students is much below standard demonstrated in the successive national learning assessments.

Therefore, this study assessed the current practices of teachers practice in implementing reasoning skills in teaching - learning of science (physics, chemistry and biology) and mathematics.

Research objectives

The main objective of the study was to assess middle school science and mathematics teacher's implementation of reasoning skills at Amhara regional state, Addis Ababa City Administration and Southern Nations, Nationalities, and Peoples' Region (SNNPR). To address this objective, the following research questions were formulated: (1) what are the current practices of teachers in using reasoning skills in middle school science and mathematics subjects to enhance students reasoning skills; (2) what effective reasoning skills/strategies do middle school teachers use to develop science and mathematics reasoning skills of students; (3) is there any significant mean difference in teachers' current practices of using reasoning in teaching upper primary science and mathematics subjects with respect to gender, educational level and subject taught.

Methods

Research design and method

The research design for this study was descriptive survey. The study employed mixed methods research as recommended by Creswell (2009) mainly focusing on quantitative research method. According to Ary et al. (2010), mixed research methods can take advantage of the combined strengths of qualitative

and quantitative approaches and can use the strengths of one method to overcome the weaknesses of another and provides stronger evidence for a conclusion of findings.

Participants of the study and sampling techniques

This study was conducted in the middle schools of three regions, Addis Ababa City Administration, Amhara region and Southern Nations, Nationalities, and Peoples' Region (SNNPR). Since there are ten sub-cities in Addis Ababa City Administration, three sub-cities and three primary schools (one from each selected sub-city) were selected by simple random sampling. Since there are thirteen zones in the Southern Nations, Nationalities, and Peoples' Region (SNNPR), three zones were selected from the zones and three complete primary schools (one from each selected zone) were selected by using cluster sampling as the zones are largely clusters of nationalities. There are also 10 zones in Amhara region, hence three zones were first selected and one school from each of the selected zones was selected randomly. Equally, all the science and mathematics teachers in the selected schools were considered as participants. Accordingly, 154 teachers participated for the questionnaire and fifty teachers selected from fifty schools for the interview.

Data collection instruments

Survey questionnaire and interview were used to assess the current practices of teachers in using reasoning skills in teachingscience and mathematics. The survey questionnaire was a five point Likert-scale on science and mathematics teachers' practices of using reasoning skills ranging from 1 = Always to 5 = Not at all. All the instruments were prepared by the thematic research team. The interview questions were focusing on emancipating deeper understanding of why teacher do the way they do with probing questions that usher insights.

Validity and reliability

The instruments were further reviewed based on the comments of professionals for the face and content validity. All the instruments were distributed to professionals for their comments and were presented in a validation workshop to get them commented and determine their validity. Moreover, pilot study was conducted on forty-five science and mathematics teachers from Addis Ababa grade 7 and 8 who are not included in the main study to determine the validity and reliability of the instruments in the Addis Ababa city administration. Cronbach alpha was calculated and the result is presented below in Table 1.

Table 1. Cronbach Alpha values for reasoning instrument and its components

No.	Variables	Cronbach Alpha	
		Pilot study	**Main study**
	Developing Students' Reasoning Skills		
	Implementation of reasoning in teaching-learning	**0.913**	**0.746**
	Planning for enhancing students' reasoning skills	0.809	0.759
	Teaching for enhancing students' reasoning skills	0.745	0.779
	Exposing students to practice the reasoning process	0.732	0.832
	Assessing students' reasoning skills	0.775	0.908

The alpha coefficients of Cronbach in Table 1 yielded greater than 0.7 for the pilot and the main study. Hence, these indicate that the instruments have acceptable internal-consistency and, thus, are reliable.

Data analysis

In this study, descriptive and inferential statistics were used for the data analysis. To this effect, descriptive statistics such as frequency tables and percentages, mean and standard deviation were used. In addition, some inferential statistics of comparison such as Independent t- test and ANOVA were used for the data analysis to see variations with respect to different categories. Qualitative data analysis was also employed from interview and open-ended questionnaire to deepen the findings.

Results

Quantitative data analysis

All in all 27 schools were selected randomly and the middle school science and mathematics teachers in those selected schools were considered as participants in this research. Table 1 shows the background of respondent teachers.

Background of the respondents

The background of respondents with respect to region, sex educational level and subject taught are described below in Table 2.

Table 2. Background respondents of teachers for reasoning questionnaire

Variables	Components	Frequency	Percent (%)
Region	Addis Ababa	31	20.1
	SNNPR	63	40.9
	Amhara	60	39.0
Sex	Female	43	27.9
	Male	111	72.1
Educational level	Diploma	97	63.0
	Bachelor Degree	57	37.0
Subject taught	Mathematics	51	33.1
	Physics	32	20.8
	Chemistry	34	22.1
	Biology	37	24.0
	Total	**154**	**100**

Teachers' practice of using reasoning skills

Table 3 below shows the descriptive statistics for science and mathematics teachers practices of using reasoning skills.

Table 3. Descriptive statistics of science and mathematics teachers' practices in using reasoning skills (N=154)

No	Variables	A	QO	S	R	NA	Mean	SD
1	I plan lessons that promote reasoning skills	59	55	30	10	0	4.06	.916
2	I plan to construct appropriate open-ended activities	50	60	35	7	2	3.97	.925
3	I design students' activity with problem solving strategy on formulation of counter and non-example	16	57	55	15	11	3.34	1.03
4	I select worthwhile tasks that engage and develop students' reasoning skills	36	61	45	8	4	3.76	.957
5	In my plan, I include a variety of opportunities for students to communicate through original thought writing, purposeful discourse, and effective questioning.	48	58	34	10	4	3.88	1.01
6	I include divergent questions or problems in my assessment plan	28	70	40	11	5	3.68	.961
7	In my plan, I include process skills to enhance students' reasoning skills	45	60	33	13	3	3.85	1.00
	Planning for enhancing students' reasoning skills						3.79	.612
8	I can make reasoning as a focus in my teaching	50	68	26	9	1	4.02	.889
9	I show the concept by formulating counter and non-example	18	53	58	17	8	3.36	1.00
10	I present the material in ways that allow students to reason about what they are doing	46	68	27	12	1	3.95	.920
11	I apply inductive and deductive reasoning techniques to build convincing arguments	39	61	41	12	1	3.81	.927
12	I create a classroom environment in which serious engagement in reasoning is the norm	44	65	39	4	2	3.94	.873
13	I effectively facilitating purposeful discourse in encouraging students to reason of what they are doing	41	62	37	10	4	3.82	.987
	Teaching for enhancing students' reasoning skills						3.82	.629
14	I guide students to show the concepts to formulate counter and non-example	16	61	47	20	10	3.34	1.04
15	I help students to apply inductive &deductive reasoning in their activities or arguments	41	70	30	10	3	3.88	.942
16	I help students to give reasons on each steps of problem solving	58	61	23	11	1	4.06	.934
17	I encourage students to understand and evaluate scientific information	62	55	27	7	3	4.08	.967
	Exposing students to practice the reasoning process						3.84	.754
18	I ask students to reflect their feelings orally or in written form in a reasonable manner	51	56	34	10	3	3.92	.994
19	I ask students to comprehend not only true example but also incorrect one.	27	52	46	17	12	3.42	1.14

20	I use various assessment strategies to monitor students' progress and promote reasoning skills	47	69	29	8	1	3.99	.874
21	I support students to judge the validity of arguments and draw appropriate conclusions	41	62	38	12	1	3.84	.930
22	I monitor the concepts and procedures used in the reasoning process	42	66	33	12	1	3.88	.921
23	I include reasoning questions in the examination	55	57	30	9	3	3.99	.983
	Assessing students' reasoning skills						3.84	.721
	Implementation/Practice in Enhancing Students' Reasoning Skills						3.82	.554

* A = Always, QO = Quite often, S = Sometimes, R = Rarely, NA = Not all

Table 3 indicated that the aggregate average value for self-reported practices of teachers in using/implementing reasoning skills was nearly 4.00 (implemented quite often) (M = 3.82) with mean values of components of planning for enhancing students' reasoning skills (M = 3.79); teaching for enhancing students' reasoning skills (M = 3.82); exposing students to practice the reasoning process (M = 3.84); and assessing students' reasoning skills (M=3.84).

For enhancing students' reasoning skills, the science and mathematics' teachers were planning lessons most frequently that promote reasoning skills; and planning to construct appropriate open-ended activities; which are (114) 74%, and (110) 71.4% respectively; whereas the least implementing was incorporating in planning is designing students' activity with problem solving strategy on formulation of counter and non-example (73) 47.4%. The others items were moderately implemented in the planning of the lesson.

In an attempt to enhance students' reasoning skills, helping students to give reasons on each steps of problem solving 119 (77.2%) was the most emphasized teachers practice. Making reasoning as a focus in the teaching (118) 76.6%; and presenting material in ways that allow students to reason about what they are doing (114) 74% were also emphasized most. In contrary, showing the concept by formulating counter and non-example (71) 46.1% was the least practiced. The others items were moderately implemented in the teaching for enhancing students' reasoning skills.

Regarding exposing students to practice the reasoning process, the most encountered practice was encouraging students to understand and evaluate scientific information (117) 75.9%; whereas the least implemented one was guiding students to show the concepts to formulate counter and non-example (77) 50%. The others items were moderately implemented in exposing students to practice the reasoning process.

In assessing students' reasoning skills, the science and mathematics' teachers frequently use various assessment strategies to monitor students' progress and promote reasoning skills (116) 75.3%; while asking students to comprehend not only true example but also incorrect ones (79) 51.3% was the least implemented. The others items were moderately implemented in exposing students to practice the reasoning process.

From the four dimensions of practice discussed above planning was highly practiced but, exposing students to practice the reasoning process was least practiced making it difficult for students to develop reasoning skills that ultimately impact their academic achievement.

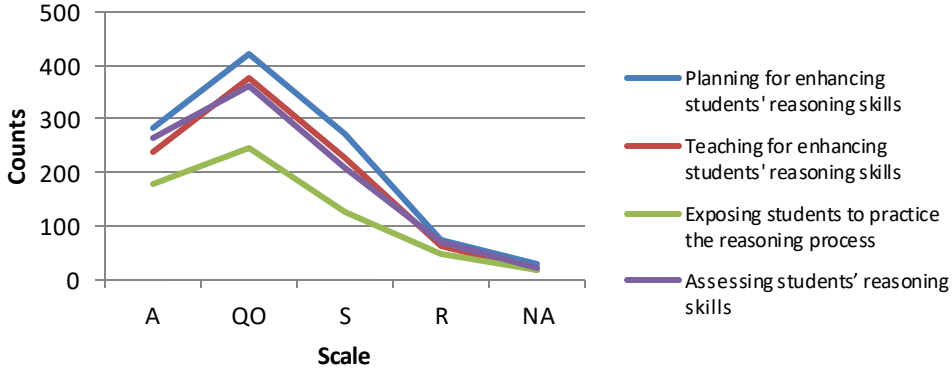

Figure 1. Line graph of teachers practice in implementing reasoning

In aggregate about 67% of the middle school science and mathematics teachers practice the four dimensions in their classroom either always (27%) or quite often (40%) to help students develop their reasoning. But, the remaining (33%) need to have developmental support as they have challenges in planning, teaching, exposing students to practice reasoning and assessing students' reasoning skills.

Sex and educational level

Since educational level and sex are important categories for practicing the four dimensions discussed above, in the below is the analyses for comparing whether there were significant differences of the science and mathematics teachers' practices in enhancing students' reasoning with respect to each of these categories.

In order to examine the with respect to sex and educational level an independent samples t-test was used after checking the assumptions of independence, normality of the data and homogeneity of variances.

Table 4 shows the descriptive statistics and independent samples t-test for science and mathematics teachers' practices in implementing reasoning skills to enhance students' reasoning skills with respect to sex and educational level.

The descriptive statistics in Table 4 shows that the mean responses of the science and mathematics teachers were higher for male than female teachers, and degree teachers higher than diploma teachers in their practice to enhance students' reasoning skills. But, the results for the independent samples t-test do not reveal any statistically significant difference between male and female teachers, and degree and diploma teachers. This implies that school teachers' sex and educational level did not affect their practice in implementing reasoning skills while teaching.

Table 4. Descriptive statistics and t-test for the responses of the science and mathematics teachers' practices in enhancing students' reasoning skills with respect to sex and educational level

Components	Variable		N	M	SD	T	df	P
Planning for enhancing students' reasoning skills	Sex	Female	43	3.69	.652	-1.23	152	.222
		Male	111	3.83	.594			
	Educational level	Diploma	97	3.77	.653	.300	152	.765
		Degree	57	3.80	.541			
Teaching for enhancing students' reasoning skills	Sex	Female	43	3.81	.670	.151	152	.880
		Male	111	3.83	.615			
	Educational level	Diploma	97	3.81	.671	-.245	152	.807
		Degree	57	3.83	.556			
Exposing students to practice the reasoning process	Sex	Female	43	3.65	.944	-1.98	152	.050
		Male	111	3.92	.657			
	Educational level	Diploma	97	3.79	.768	-1.16	152	.249
		Degree	57	3.93	.727			
Assessing students' reasoning skills	Sex	Female	43	3.72	.831	-1.34	152	.181
		Male	111	3.89	.671			
	Educational level	Diploma	97	3.79	.773	-1.16	152	.247
		Degree	57	3.93	.619			
Enhancing students' reasoning skills	Sex	Female	43	3.73	.623	-1.29	152	.200
		Male	111	3.86	.523			
	Educational level	Diploma	97	3.80	.593	-.638	152	.524
		Degree	57	3.86	.482			

Subject teachers teach

Since teachers of four subjects were included as participants in this study, One-way ANOVA test was used to see the significance of differences of the science and mathematics teachers' in enhancing students' reasoning skills

with respect to the subjects they teach. The assumptions of independence, normality of the data and homogeneity of variances were met.

Table 5 shows the descriptive statistics and ANOVA for science and mathematics teachers' practices in enhancing students' reasoning skills with respect to subject they teach.

Table 5. Descriptive statistics and ANOVA test for the responses of science and mathematics teachers' practices in enhancing students' reasoning skills with respect to subject they teach

Components	Variables	N	M	SD	F	P
Planning for reasoning skills	Mathematics	51	3.81	.609	.173	.915
	Physics	32	3.84	.626		
	Chemistry	34	3.74	.607		
	Biology	37	3.78	.630		
Teaching for reasoning skills	Mathematics	51	3.82	.580	.195	.900
	Physics	32	3.77	.767		
	Chemistry	34	3.80	.571		
	Biology	37	3.88	.635		
Exposing students to practice the reasoning process	Mathematics	51	3.79	.799	.425	.735
	Physics	32	3.89	.835		
	Chemistry	34	3.77	.614		
	Biology	37	3.94	.751		
Assessing students' reasoning skills	Mathematics	51	3.85	.745	.267	.849
	Physics	32	3.92	.707		
	Chemistry	34	3.84	.679		
	Biology	37	3.77	.756		
Enhancing students' reasoning skills	Mathematics	51	3.82	.534	.080	.971
	Physics	32	3.85	.607		
	Chemistry	34	3.79	.470		
	Biology	37	3.83	.621		

Table 5 indicates that there is no statistically significant difference in the practices of teachers to enhance students' reasoning skills between subjects they

teach. These indicate that the science and mathematics teachers were not different in enhancing students' reasoning skills. This also indicates that should there be any attempt to develop the skills of the teachers, it can be implemented to all subject teachers equally.

Qualitative data analysis on reasoning

Below are the responses of the teachers for the reasoning approach for each question: (1) what procedures do you follow to get students' reasoning; (2) Do you have the required knowledge and skills in applying the reasoning strategies in your teaching; (3) what are the challenges to make reasoning as a focus of teaching-learning.

Mostly used procedures to get students' reasoning (2 to 4 groups) were: starting the lesson by asking oral questions, asking WH question during and after students' presentations, giving different activities for students to discuss individually or in group, asking students to reason out about their understanding of the topic, listening carefully to students' questions and responses, giving different activities for students to discuss individually or in groups, presenting by telling, showing and doing, giving semi-structured and structured feedback and response, giving hints when students stuck in their reasoning process, explaining the concepts in groups to reason out their understanding, motivating students to ask questions, asking students to show the mathematical procedures they should follow on the blackboard, follow and support students in their process of reasoning, allowing students to get feedback from their peer and teacher, and giving quiz and test with prompt feedback for logical numerical reasoning.

Most of the teachers responded that they had somehow the required knowledge and skills in applying the reasoning strategies in their teaching; and only few teachers claimed that they had the required knowledge and skills in applying the reasoning strategies in their teaching. Some of the teachers re-

sponded that they had least knowledge and skills in applying the reasoning strategies in their teaching; whereas some others replied that they didn't have the required knowledge and skills in applying the reasoning strategies in their teaching. Also, some of the respondents mentioned that they are unable to apply reasoning strategies because of lack of proficiency in medium of instruction, which is English. Some other respondents also mentioned that the extended use of teacher centered methods prevented them from applying reasoning strategies. Whereas, few respondents of the teachers interviewed pointed out that except questioning method they did not use any other reasoning strategies.

The challenges mentioned by most respondents were: lack of motivation of students to involve in the reasoning process, knowledge gap of students in their subject matter, and lack of knowledge and skills of teachers in applying reasoning strategies. The challenges mentioned by some respondents were: lack of students' proficiency in the medium of instruction, shortage of time, shortage of resources and materials, lack of readiness and commitment of teachers in applying reasoning strategies, content overload, activities in textbooks do not promote reasoning, and lack of teachers' proficiency in the medium of instruction. The challenges mentioned by fewer respondents were: teachers lack knowledge of the subject matter, large class size, lack of training of teachers in reasoning strategies during their stay in teacher education, student absenteeism, poor background of students in reasoning, teachers' lack of skills in motivating students and in triggering the reasoning process, and difficulty of subjects like physics and mathematics made the reasoning process unused.

Discussion

This study investigated middle school science and mathematics teachers' current practices in implementing reasoning skills/different strategies so as to enhance students reasoning skills and whether their practice differs with respect to variables such asgender and educational level, and subject they teach.

Development of students reasoning skills may be influenced by many interrelated factors, including teacher, curriculum, instructional method, school and quality education provided. Among all these factors, teachers have a central role in enhancing students reasoning skills (Kulm, 1994) and this study focused on teachers' practices.

This study revealed that the teachers have a moderate practice in implementation of reasoning skills. The result revealed that teachers were planning using reasoning skills; teaching with reasoning skills; exposing students to practice the reasoning process; and assessing students' reasoning skills always (27%) and quite often (40%) for enhancing students' reasoning skills. It was revealed most teachers frequently prepare plans that promote reasoning skills with appropriate open-ended activities that enhance students reasoning skills but were least in designing students' activity with problem solving strategy on formulation of counter and non-examples.

It was also found that the science and mathematics' teachers were making reasoning as a focus of their teaching; and most frequently present the material in ways that allow students to reason about what they are doing but were least in showing a concept by formulating counter and non-examples while teaching.

Similarly, teachers most frequently encourage students to understand and evaluate scientific information to expose them to practice the reasoning process but were least in guiding students to show the concepts by formulating counter and non-examples.

In relation to assessing students' reasoning skills, most teachers frequently use various assessment strategies to monitor students' progress and promote reasoning skills but they were least in asking students to comprehend not only true example but also incorrect ones. From the result, it was clearly shown that teachers have a difficulty in incorporating counter and non –examples to enhance students reasoning skills.

The qualitative result also indicated that teachers were implementing some reasoning skills and had somehow the required knowledge and skills in applying the reasoning strategies in their teaching. However, they mentioned they faced different challenges to implement reasoning skills such as lack of motivation of students to involve in the reasoning process, knowledge gap and level of students in their subject matter, and lack of knowledge and skills of teachers in applying reasoning strategies; lack of students' proficiency in the medium of instruction, shortage of time, shortage of resources and materials, lack of readiness and commitment of teachers in applying reasoning strategies, content overload, activities in textbooks do not promote reasoning, and lack of teachers' proficiency in the medium of instruction.

The findings from independent samples t-test also illustrated that there was no significant difference between teachers' in enhancing students' reasoning skills; with respect to their gender and education level.

Similarly, the ANOVA result revealed that there was no statistically significant difference between groups of teachers with respect to subjects they in enhancing students' reasoning skills. These indicated that the science and mathematics teachers were similar in enhancing students' reasoning skills; planning for reasoning skills; teaching for reasoning skills; exposing students to practice the reasoning process; and assessing students' reasoning skills in the subjects they teach.

To sum up, teachers were not always implementing reasoning skills while teaching science and mathematics. Therefore, the science and mathematics teachers have challenges in planning, teaching, exposing students to practice and assessing students' reasoning skills. Literature indicated that teachers' effective implementation of different reasoning skills while teaching is important to enhance students reasoning skills so as to improve their academic achievement (Tajudin & Chinnappan, 2015; Jaleel & Premachndra, 2017; Zimmerman, 2005). This is because reasoning has direct relationship with students' academic achievement (Jaleel & Premachndra, 2017). Reasoning has also an impact on

scientific, critical, and creative thinking, argumentation, problem solving, and decision making (Jaleel & Premachandran, 2017; Morris et al., 2012; Tajudin & Chinnappan, 2015). Thus, gaps in implementing reasoning skills will have an impact on the student achievement, and one can see this with the declining achievement of students as demonstrated in the national learning assessments conducted in Ethiopia (every four years from 2000 – 2016)

Conclusion and recommendation

The result of this study may give insight in to the level of the current practice of middle school teachers in implementing reasoning skills and the challenges they faced. Middle schools' science and mathematics teachers were implementing reasoning skills in their teaching but they were not implementing to the extent one could expect with 33% of the teachers either not implementing at all or are implementing rarely. Teachers in the middle schools of Ethiopia must improve their practice in implementing reasoning skills to enhance students' overall reasoning skills and academic performance. Thus, concerned bodies like MOE and regional and city administration education offices should realize the problem and design mechanism to alleviate the problem, for instance by offering frequent on job training to enhance teachers' awareness and actions for practice towards implementing reasoning skills to enhance students' academic achievement.

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